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United States Department of Agriculture,

DIVISION OF BOTANY.

THE CAMPHOR TREE.

(*Cinnamomum camphora* Nees & Eberm.)

DESCRIPTION.

The camphor tree is a broad-leaved evergreen, related to the red bay and to the sassafras of the United States. In its native habitat it attains a height of 60 to 100 feet, with wide-spreading branches and a trunk 20 to 40 inches in diameter. Its general habit is similar to that of the basswood. The leaves are broadly lanceolate in form, with acuminate points at both base and apex, of a light green color, smooth and shining above, and whitish, or glaucous, on the under surface. The lower pair of lateral veins are more prominent than the others, but the leaves are not as distinctly 3-nerved as those of the cinnamon and many other species of the genus. The small white or greenish-white flowers (fig. 1, *b*), are borne in axillary racemes from February to April on shoots of the previous season, and are followed in October by berry-like, one-seeded fruits about three-eighths of an inch in diameter (fig. 1, *c*). The fruiting pedicels terminate in a saucer-shaped disk, persisting after the mature fruit has fallen.

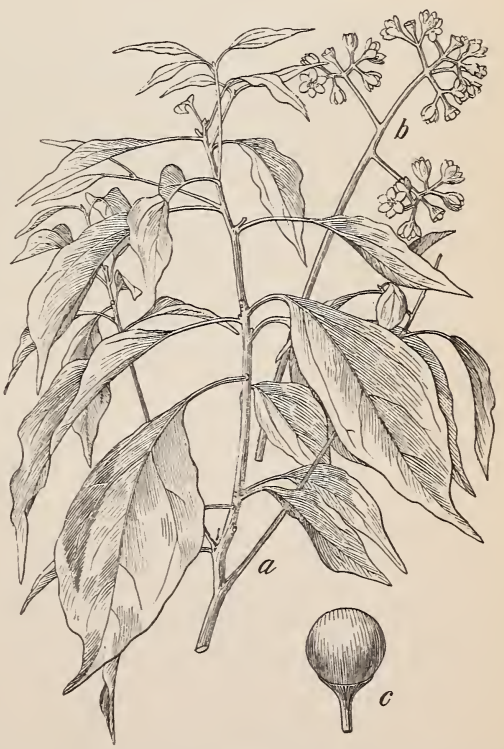

Fig. 1.—Camphor tree: *a*, young leafy shoot, scale one-third; *b*, flower cluster, life size; *c*, fruit, life size.

NATIVE RANGE.

The camphor tree is native in the coast countries of Eastern Asia from Cochin China nearly to the mouth of the Yang-tse-kiang and on the adjacent islands from the southern part of the Japanese Empire, including Formosa and the Ryukyu Islands, to Hainan, off the coast of Cochin China. Its range also extends into the interior of China as far as the province of Hupeh, about 500

miles from the coast on the Yang-tse-kiang, in latitude 30° north. This area, extending from 10° to 34° north latitude and from 105° to 130° east longitude, is all embraced in the eastern monsoon region, which is remarkable for abundant rains in summer.

The camphor trees growing wild in the native range are usually most abundant on hillsides and in mountain valleys where there is good atmospheric as well as soil drainage. The temperature in the greater part of this region, which is partly within the tropics and partly subtropical, rarely falls below freezing. The tree is an evergreen, changing its leaves generally in April, and therefore the winter temperature is a factor of more importance than would be the case with a deciduous tree.

RANGE UNDER CULTIVATION.

Notwithstanding the comparatively narrow limits of its natural environment, the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalized in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in southeastern France, and in the San Joaquin Valley in California, where the summers are hot and dry. Large trees, at least two hundred years old, are growing in the temple courts at Tokyo, where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12o to 16 F. The most northern localities in the United States, so far as known at this Department, where the camphor tree has been grown successfully out of doors are Charleston and Summerville in South Carolina, Augusta, Ga., and Oakland, Cal.

At Charleston, Summerville, and Augusta the trees have withstood a minimum temperature of 15° F., but they have been protected by surrounding trees and buildings. At Mobile, Ala., the trees have grown and fruited in protected situations, while in exposed places they have been repeatedly destroyed by frosts. While the camphor tree will grow on almost any soil that is not too wet, it does best on a well-drained sandy or loamy soil, and it responds remarkably well to the application of fertilizers. Its growth is comparatively slow on sterile soils, but under favorable conditions it sometimes grows very rapidly. An instance is recorded of a camphor tree in Italy a foot in diameter and 90 feet high, eight years from the seed. Under ordinary conditions, however, such a girth is not often attained in less than twenty-five years, and such a height is rarely attained in a century. A tree planted at New Orleans in 1883 is now 40 feet in height with a trunk 18 inches in diameter at the base and 8 feet to the first limbs. Under favorable conditions an average of 30 feet in height, with trunks 6 to 8 inches in diameter at the base, may be expected in trees ten years from the seed.

USES OF THE TREE AND ITS PRODUCTS.

The principal commercial uses of the camphor tree are for the production of camphor gum and camphor oil. Camphor gum is employed extensively in medicine. It enters into the composition of many kinds of liniments for external application. For liniment it is used especially in combination with olive oil. It is taken internally for hysteria, nervousness, nervous headaches, diarrhea, and diseases affecting the alimentary canal. It is specific in cases of typhoid

fever and cholera. Camphor fumes have been used with success in cases of asthma. It has been used very extensively to keep insects out of furs, woolens, etc. In Japan camphor and camphor oil are used in lacquer work. The oil is somewhat similar to turpentine. It dissolves resins and rubber, and after being separated by fractional distillation into oils of different weights it is used in varnishes, paints, and soaps, and to protect leather against insects. In Japan and China it has been used for illuminating purposes, but it produces a smoky flame.

Among the secondary uses of the camphor tree the most important is for ornamental planting. Its bright evergreen leaves, rapid growth, and long life make it valuable for this purpose. In Japan and China it has been the principal tree planted in the temple courts for many centuries, and in those countries it takes the place of the historic oaks of England. It has been extensively introduced into Southern Europe and South America for ornamental purposes.

The wood, with its close grain, yellow color, and susceptibility to polish, taking a kind of satin-like finish, is exceedingly valuable in cabinetwork, especially for making drawers, chests, and cupboards proof against insects. The leaves and young branches, although they have but a slight odor of camphor, are packed with clothing or scattered about unused rooms to guard against insects.

The tree produces an abundance of berry-like fruits, which are used in Japan and China to make a kind of tallow. The fruits are greedily eaten by chickens and birds, especially mocking-birds, which often select camphor trees for nesting places.

CONDITIONS OF SUCCESSFUL CULTIVATION.

For most of the secondary purposes, the camphor tree may well be cultivated wherever it can be made to live; but for the distillation of gum and oil with a commercial view, and for the production of wood for cabinet purposes, it must be grown under the most favorable conditions. The minimum winter temperature should not be below 20° F., and this minimum should be of rare occurrence. The soil, preferably sandy and well drained, should be irrigated unless there are abundant rains. Fifty inches of water during the warm growing season is desirable, and much more may well be used where the air is very dry.

An abundance of plant food, rich in nitrogen, is required for rapid growth, but the kind of fertilizer that can be most profitably applied will vary according to the character of the soil in each locality. In the absence of definite information in this regard the kind of fertilizer producing most rapid growth of wood in the orange or in other fruit trees may be taken as an index.

The northern boundary of the dotted area on the accompanying map (fig. 2) marks, approximately, the limit within which the camphor tree may be grown in situations protected by buildings or by other trees, while the northern limit of the area shaded by lines marks the approximate boundary of the area within which it may be grown without protection. Further experiments in planting the camphor tree will doubtless modify both of these lines somewhat. It is hoped that by continued selection of seeds from the most hardy trees plants may be bred up to endure more cold.

PROPAGATION.

Camphor trees may be grown either from seed or from cuttings. They are usually grown from seed, as the trees fruit abundantly, and seedlings can be grown more easily than cuttings. The seeds are collected at maturity in October and November, and after drying are packed in sharp white sand or some similar material to keep them fresh until the time of planting in spring. About the last of March they are sown in drills in the seed bed.

The soil of the seed bed should be a good sandy loam mixed with about one-third leaf mould. The seed bed should be kept moist, but not too wet, and should be shaded from the direct rays of the sun if the weather is warm. The best soil temperature for germinating camphor seeds is from 70° to 75° F. The temperature of the atmos-

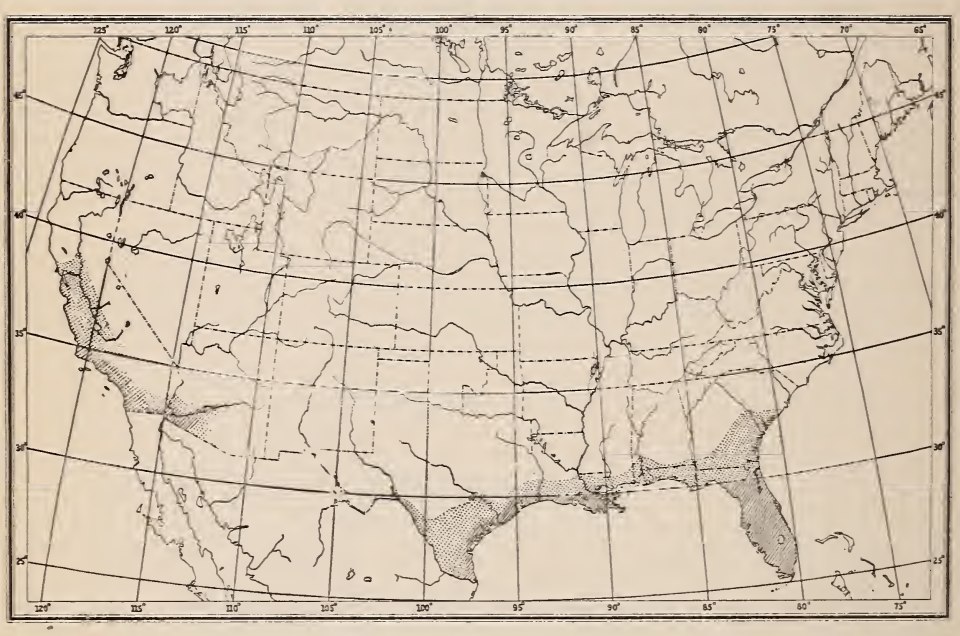

FIG. 2.—Map showing approximate areas where the camphor tree may be grown in the United States. In the dotted area protection from cold will be required. In the line-shaded areas protection will not often be required except in exposed situations and on the mountains of California.

phere may be ten degrees higher. The seedlings will grow well at higher temperatures, but are likely to lack vigor and hardiness.

The seedlings may be grown in pots, which will facilitate transplanting at any time, or they may be transplanted in nursery rows early in April when one year old. Plants two years old are generally regarded as best for final planting. At this age they vary from 20 to 40 inches in height.

PLANTING AND CULTIVATION.

When set out for ornamental purposes, the camphor tree may be expected to grow, in favorable situations, about as rapidly as a Le Conte pear, and to require about as much room. In Japan, where the law requires that a new tree shall be set out for every one cut, they are not generally set in straight orchard rows, but cultivation there is performed almost exclusively by hand labor. There are no records

showing results of regular orchard planting, hence the distances at which trees should be planted must be determined by the size and form of the trees and the methods of cultivation and of procuring the gum. They may be set closely in rows about 10 feet apart, and alternate rows cut and reset every five years, thus producing bush-like plants of ten years' growth. They may be planted in checks 10 feet square, and alternate trees cut every ten or twelve years, or they may be planted in larger checks, and all of the trees be cut at the age of fifteen or twenty years.

There are not sufficient data obtainable upon which to base definite statements as to the best methods of planting or the age at which the trees may be cut with greatest profit for the production of gum. A recent English consular report from Japan states that "although hitherto the youngest wood from which camphor was extracted was about seventy to eighty years old, it is expected that under the present scientific management the trees will give equally good results after twenty-five or thirty years." Camphor of good quality has been produced in Florida from the leaves and twigs of trees less than twenty years old, 1 pound of crude gum being obtained from 77 pounds of leaves and twigs.

The trees will endure severe pruning with little apparent injury. One-third of the leaves and young shoots may be removed at one time without materially checking the growth of the tree. The largest proportion of camphor is contained in the older, larger roots; the trunk, limbs, twigs, and leaves containing successively a decreasing proportion. When the camphor tree is killed nearly to the ground by frost it sends up vigorous shoots from the base. It may be expected to do the same when cut, especially if cut late in the fall. Experiments are needed to determine whether this growth may be depended upon, or whether it will be more profitable to dig out the larger roots and set out new seedlings.

DISTILLATION OF CAMPHOR GUM.

In the native forests camphor is obtained almost exclusively from the wood of the trunks and the larger roots and branches. These are first chopped into small pieces and sometimes pounded or bruised to facilitate distillation. The work is performed by hand labor and the processes in use seem rather crude. In some parts of Formosa a layer only about an inch thick is cut from the larger roots and from part of the trunk, the object being to obtain the best camphor bearing wood without killing the tree. Trees thus treated often die. Where trees are cut down the best parts of the trunks are sometimes saved for lumber. From 20 to 50 pounds of chips are required for one pound of crude gum. Trees fifty years old in Formosa yield an average of about 133 pounds of crude gum. Many different forms of stills and different methods of distillation are employed in different districts, but all result in a separation of the gum from the wood by means of steam or hot water.

In Fukien, China, the chips are sometimes soaked in water several days and the water, together with the chips, distilled. The form of still in common use there consists of a metal pan to receive the water and chips, supported above a fireplace. Over this pan is placed a large cone of rice straw coated on the outside with a layer of mud.

When the fire is started the steam rises in the cone carrying with it the camphor gum which collects in flakes on the straw. Sometimes the chips are merely steeped in water and the gum skimmed off as the water cools.

A common form of still used by the natives in Formosa consists of a trough, hollowed out of a tree trunk, supported over a fire from which it is protected by a coating of mud. This trough is partly filled with water and is covered with a plank in which there are several groups of small holes. Camphor chips are piled over each group of holes and covered with an inverted earthen pot. As the water is heated the steam rises through the holes in the plank and passes through the pile of chips carrying with it the camphor gum, which is deposited in the upper part of the pot. A form of still used by the Germans in Formosa consists of a series of fireplaces made of mud bricks, supporting shallow pans of water. Above each pan and partly inclosed in the brickwork is a cylinder about a foot in diameter with a perforated bottom for holding the chips. A large earthen jar, inverted over the top of the cylinder and fitting it closely, collects the camphor, which crystallizes upon cooling. A simpler process in use in Formosa consists in boiling the chips in an iron pot, the camphor being collected in an earthen jar inverted over the top of the pot.

The most skillful methods of distillation are practiced in the island of Kiu Shiu, Japan. Camphor trees, selected by a government inspector, are felled and the trunks, larger limbs, and sometimes the roots, are cut into chips by hand labor with a sharp concave adz. The fresh chips are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering toward the top like an old-fashioned churn. The perforated bottom of the tub fits tightly over an iron pan of water on a furnace of masonry. The tub has a tight-fitting cover which may be removed to put in the chips. It is surrounded by a layer of earth about 6 inches thick to aid in retaining a uniform temperature. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This chamber is kept cool by a constant stream of water falling on the top, running down over the sides and out through a hole in the larger tub. The upper part of the condensing chamber is sometimes filled with clean rice straw on which the camphor crystallizes, while the oil drips down and collects on the surface of the water. In some cases the camphor gum and oil are allowed to collect together on the surface of the water and are afterwards separated by filtration through rice straw or by pressure. In another form of condenser the steam is conveyed by a bamboo tube into an inclosed tub and from this it passes by a tube to a second tub containing several vertical partitions open at alternate ends and with screens of bamboo lattice work at intervals in the passage ways. A large proportion of the water condenses in the first tub. The camphor collects on the screens in the circuitous passage in the second tub and the oil drains down from these, collecting in the bottom.

Where the chips are distilled by steam about twelve hours are required for the process. The apparatus is not strong enough in any case to hold steam under pressures exceeding more than two or three pounds, limiting the range of temperature to from 212° to 250° F.

The principles generally held to be essential in distilling camphor of good quality are: (1) The heat must be uniform and not too great, producing a steady supply of steam; (2) the steam after liberating the camphor must not come in contact with metal, that is, the tub and condensing apparatus must be of wood or earthen ware.

SUGGESTED IMPROVEMENTS.

Many improvements upon the methods described can doubtless be made, tending both to a reduction in cost and an increase in the proportion of crude gum obtained. Instead of an adz wielded by hand a machine similar to the "hog" used for grinding up waste slabs in sawmills may be used to reduce camphor limbs to the requisite fineness for distillation. Better distilling apparatus can probably be devised. Thermometers may be introduced to determine the heat in the distilling tub, and the furnace may be so arranged as to permit better control and greater economy in fuel. Improvements may be made in the condensing chamber for collecting the gum and oil in such a manner that it may be easily removed.

REFINING.

The first distillation produces only crude camphor gum, the quality and market value of which depend chiefly on its freedom from water, oil, and all impurities. The crude gum is refined before it is placed on the retail market. The refining process commonly consists in mixing with the crude gum about 2 per cent of its weight of both carbonate of lime and bone-black, and subliming it in closed cast-iron jars at a fixed temperature just below 400° F., the point at which it volatilizes. This process requires carefully constructed apparatus and very skillful manipulation. It is not likely that it can be carried on advantageously even by large growers. The best refined camphor should be entirely free from water, oil, or any impurity, and should evaporate in time, leaving no residue whatever.

OUTLOOK FOR FUTURE MARKET.

The consumption of camphor in this country, as measured by the importations, has been decreasing during the past ten years, while the price has been increasing, as indicated by the following table:

Imports, values, and approximate values per pound of camphor for years ended June 30, 1887–1896, and for 9 months ended March 31, 1897.

Years.	CRUDE CAMPHOR—DUTY FREE.			REFINED CAMPHOR—DUTIABLE.			
	Quantities.	Values.	Value per pound.	Quantities.	Values.	Value per pound.	Rates of duty.
	Pounds.			*Pounds.*			*Per lb.*
1887	2,873,184	$352,861.00	$0.12	307	$45.00	$0.15	5 cents.
1888	2,779,719	304,460.00	.11	61	7.77	.13	Do.
1889	1,974,500	293,031.44	.15	72	10.50	.15	Do.
1890	2,061,370	421,385.00	.20	87	37.75	.43	Do.
1891	1,666,074	468,025.00	.28	63	21.23	.33	4 cents.
1892	1,955,787	447,634.00	.23	56,820	17,361.00	.31	Do.
1893	1,723,425	446,548.00	.26	156,291	51,229.33	.33	Do.
1894	1,323,932	309,407.00	.23	137,882	44,233,00	.32	Do.
1895	1,509,713	284,958.00	.19	271,164	83,382.00	.31	(*)
1896	943,205	328,457.00	.35	153,912	68,785.00	.45	(*)
For 9 months, March 31, 1897 (latest reports obtainable).	855,284	207,137.77	.24	155,027	52,811.00	.34	(*)

* Ten per cent ad valorem.

The tariff act approved July 27, 1897, imposes a duty of 6 cents per pound on refined camphor and leaves crude camphor on the free list, as heretofore.

There has been an increase in importations of refined camphor, due to improved methods of refining and packing in Japan and to changes in the tariff, but this increase has been much more than counterbalanced by the decrease in importations of crude camphor. The decrease may be attributed to the following causes: (1) The exhaustion of the supply of the available camphor trees near the shipping ports; (2) the governmental restrictions on the trade in camphor in Formosa; (3) government taxes on the exportation of camphor from Formosa; (4) hostilities and wanton destruction of camphor stills by the natives in Formosa; (5) disturbances in the camphor-producing district of China; (6) the China-Japan war; (7) attempts by speculators to corner the market.

These causes have increased the price of camphor, and this in turn has led to the introduction of substitutes. Menthol and other peppermint derivatives or compounds, carbolic acid and its derivatives, napthalin, formalin, and insect powder are now used for various purposes where camphor was formerly employed. Artificial camphors nearly equal to that obtained from the camphor tree have been produced by several different methods. It is therefore apparent that if the production of camphor from the trees is to be carried on with profit in this country and the industry increased to any considerable extent, the price of camphor must be reduced to compete with the price of substitutes now taking its place.

Camphor has been obtained from several other plants not at all related to the ordinary camphor tree, but only two kinds, Barus or Borneo camphor and Malay or Blumea camphor, are of any importance commercially.

Borneo camphor is obtained from *Dryobalanops aromatica*, the Kapur Barus or camphor tree of Borneo and Sumatra. It is deposited in clefts and hollows in the wood, and has simply to be taken out. This camphor is comparatively rare and the supply is consumed almost exclusively in China, where it is valued at from thirty to ninety times as much as ordinary camphor.

Blumea camphor or ngai is obtained by distillation from *Blumea balsamifera*, a shrub growing in Burmah and the Malay Peninsula. This is usually refined in Canton, whence about 10,000 pounds are exported annually. The source of this supply is abundant, and as the industry develops it is likely to enter more into competition with ordinary camphor. Neither of these plants can be grown in the United States, except possibly in southern Florida, without protection against cold.

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